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ILLUSTRATIONS

TO

HOW TO WORK

WITH

THE MICROSCOPE,

BY

LIONEL BEALE, M.B., F.R.S.

PROFESSOR OF PHYSIOLOGY IN KING'S COLLEGE, LONDON; PHYSICIAN TO KING'S COLLEGE HOSPITAL, HONORARY FELLOW OF KING'S COLLEGE, ETC.

CONTAINING UPWARDS OF 150 SEPARATE FIGURES.

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LIST OF ILLUSTRATIONS.

The following Plates have been so arranged that they may be inserted opposite certain pages of "*How to Work with the Microscope.*" Several of the engravings have been published in the Author's larger work on "*The Microscope in its application to Practical Medicine,*" but as they illustrate instruments and arrangements employed in all branches of microscopical investigation, and objects of general interest, they have been repeated here.

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PLATE II. ANGLE OF APERTURE—SPHERICAL AND CHROMATIC ABERRATION —STAGE AND MIRROR OF MICROSCOPE.

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PLATE XIII. SCISSORS — SPRING SCISSORS — SECTION KNIFE — DOUBLE-BLADED OR VALENTIN'S KNIFE—FORCEPS.

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PLATE XXIV. INSTRUMENTS AND APPARATUS REQUIRED FOR MAKING INJECTIONS.

PLATE XXV. SIZES OF THE PARTICLES OF DIFFERENT COLOURING MATTERS USED FOR INJECTION.

PLATES XXVI. BOTTLES WITH CAPILLARY ORIFICES FOR HOLDING TEST SOLUTIONS—TEST TUBES.

PLATES XXVII. INVERTED MICROSCOPE — APPARATUS FOR EXAMINING OBJECTS AT A HIGH TEMPERATURE.—PHOTOGRAPHIC CAMERA.

PLATE XXVIII. EXTRANEOUS MATTERS WHICH OFTEN FALL ACCIDENTALLY INTO MICROSCOPICAL PREPARATIONS WHEN THEY ARE BEING MOUNTED.

PLATE I

Fig. 1.

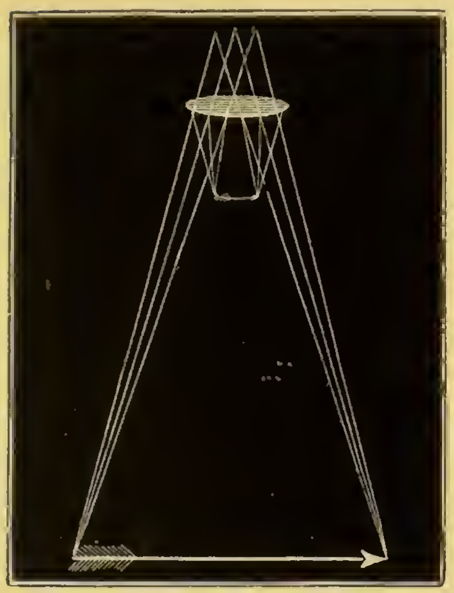

Fig. 2.

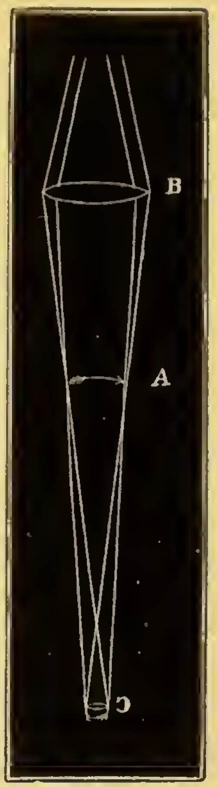

Fig. 3.

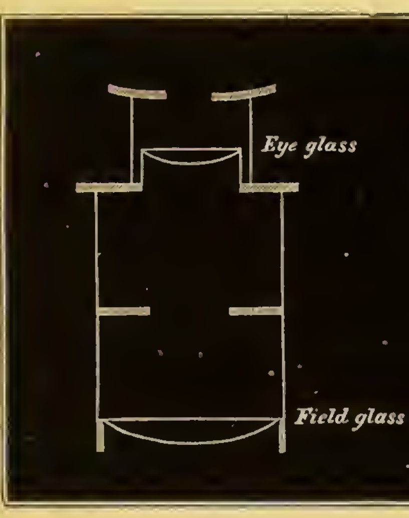

Fig. 4.

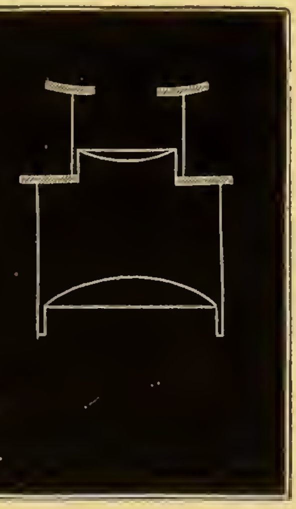

Fig. 5

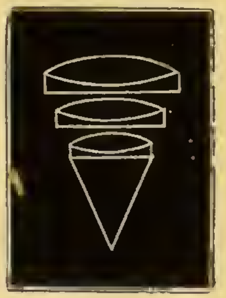

Fig. 1. Illustrates the manner in which an object is magnified by the simple microscope or by a lens (p. 5).
Fig. 2. Diagram of compound microscope. A. Point where the object is brought to a focus by the object-glass (C). The image formed at this point is magnified again by the eye-piece B (p 5).
Fig. 3. Negative or Huyghenian eye-piece. Fig. 4. Positive eye-piece invented by Ramsden (p. 5).
Fig. 5. Compound glasses of an achromatic object-glass (p. 6).

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PLATE II.

Fig. 6.

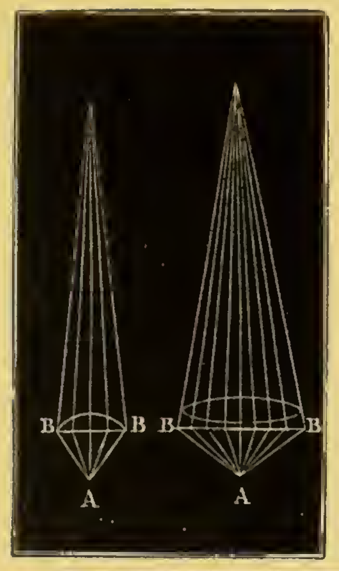


Fig. 7

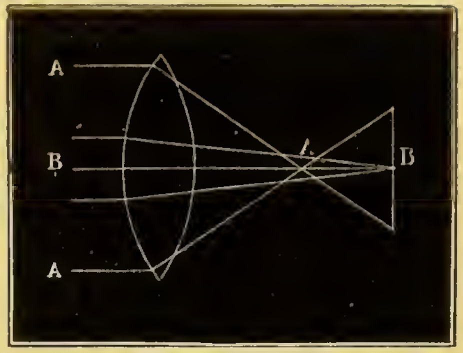


Fig. 8.

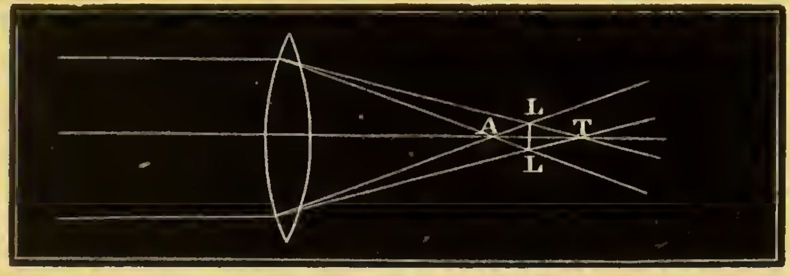


Fig. 9.

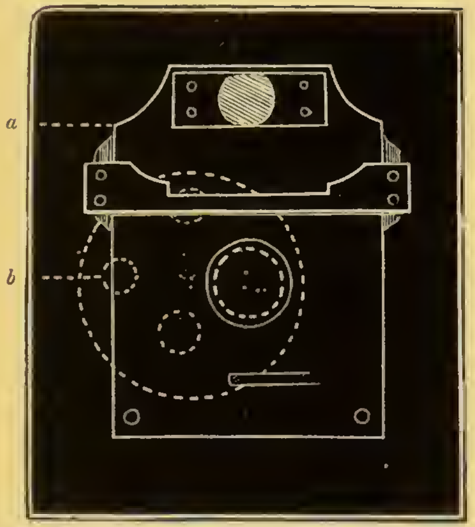


Fig. 10.

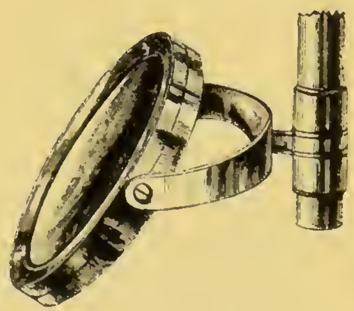
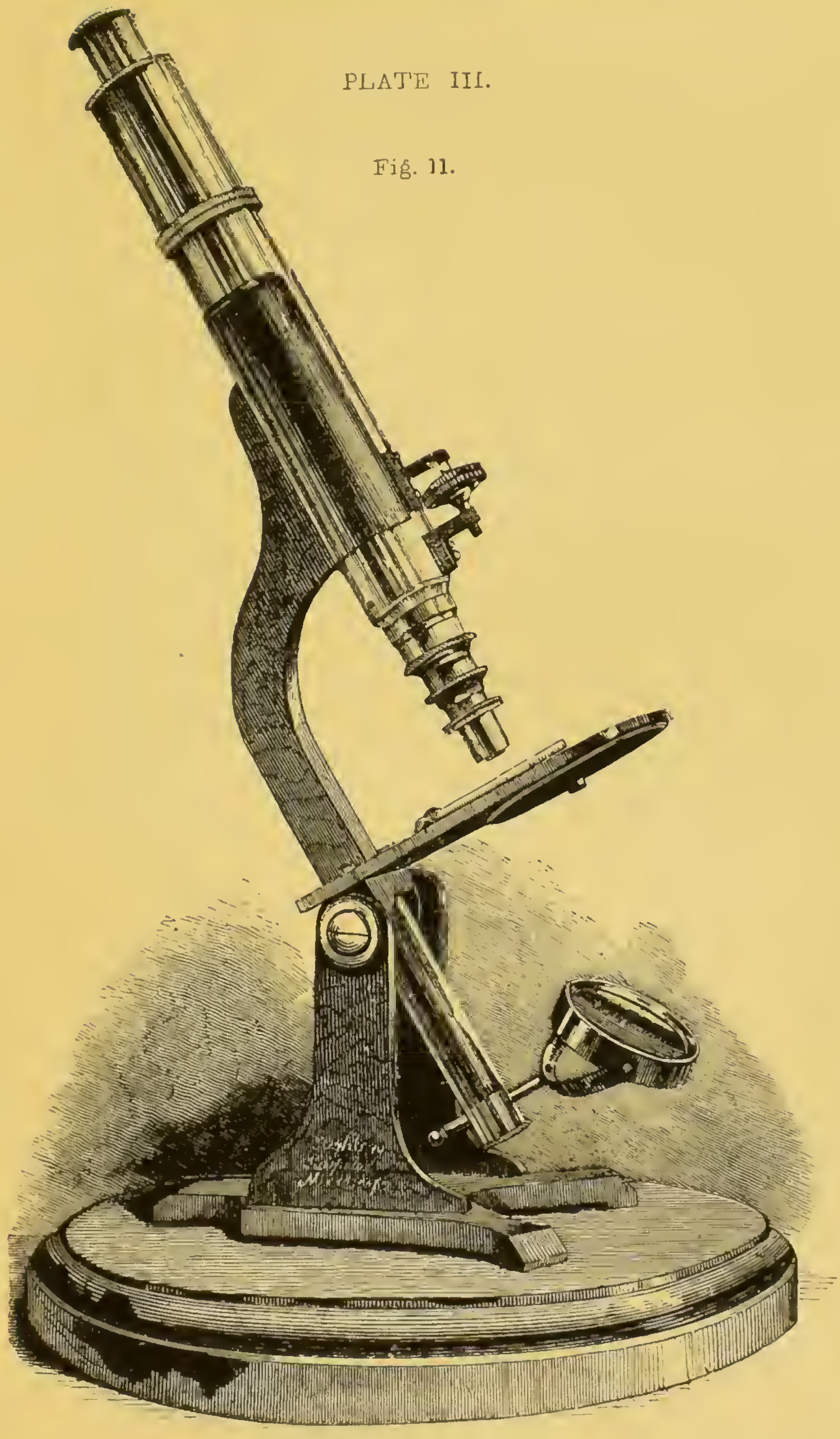


Fig. 6. Objective, with low angle of aperture B A B. Another with high angle of aperture B A B (p. 6).
Fig. 7. To illustrate "spherical aberration." The rays A A being more refracted than those near the centre B, are brought to a focus nearer the lens (p. 6.)
Fig. 8. To illustrate "chromatic aberration." The violet and blue rays being most refrangible are brought to a focus, A, nearer the lens than the red rays, T, which are the least refrangible of the rays of the spectrum. Any object placed at L L would exhibit coloured fringes (p. 6).
Fig. 9. Stage of student's microscope, showing diaphragm (p. 17) placed beneath. From *a* to *b* should not be less than two inches (p. 8).
Fig. 10. Mirror.

[To face page 6.]

PLATE III.

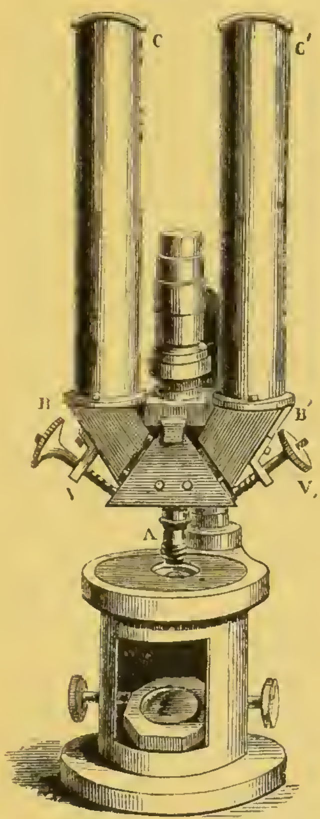
Fig. 11.



Student's microscope, designed by Mr. Highley, and made by Mr. Ladd, on a stand, so that it may be readily covered with a glass shade (p. 10).

[To face page 8.]

Fig. 12. PLATE IV. Fig. 13.



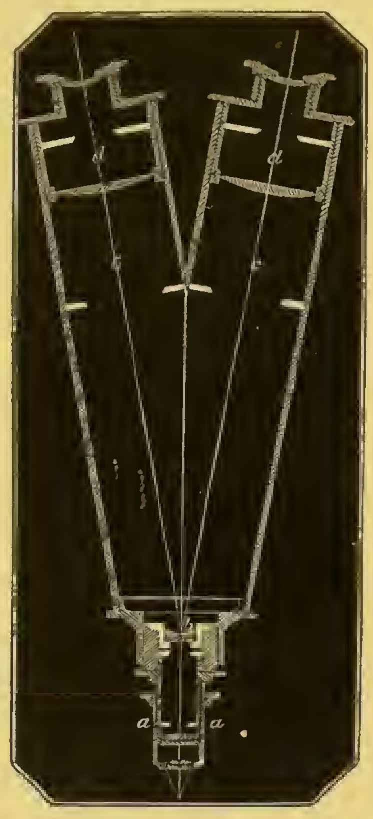


Fig. 14.

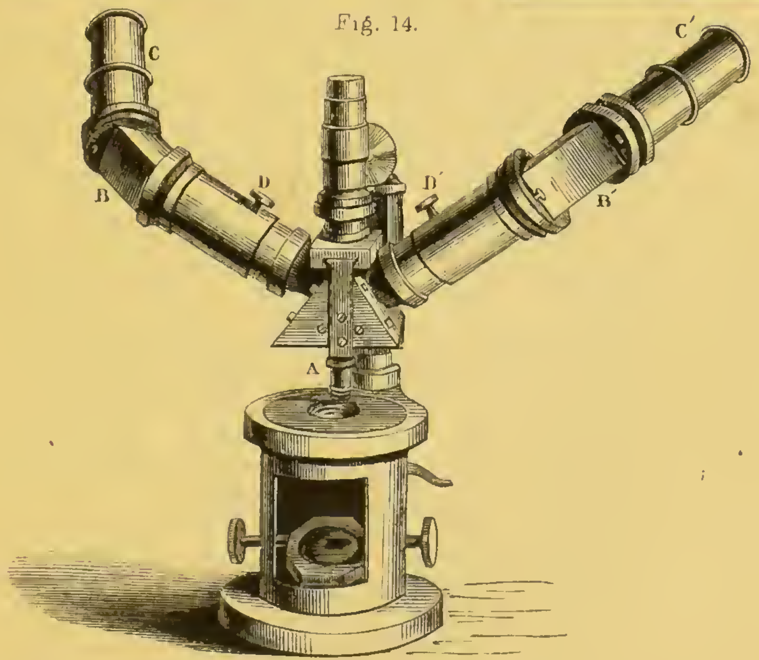


Fig. 12. Nachet's binocular microscope (p. 11).
Fig. 13. Binocular microscope as arranged by Mr. Wenham.
Fig. 14. M. Nachet's microscope to enable two observers to examine an object at the same time.

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PLATE V.

Fig. 15.

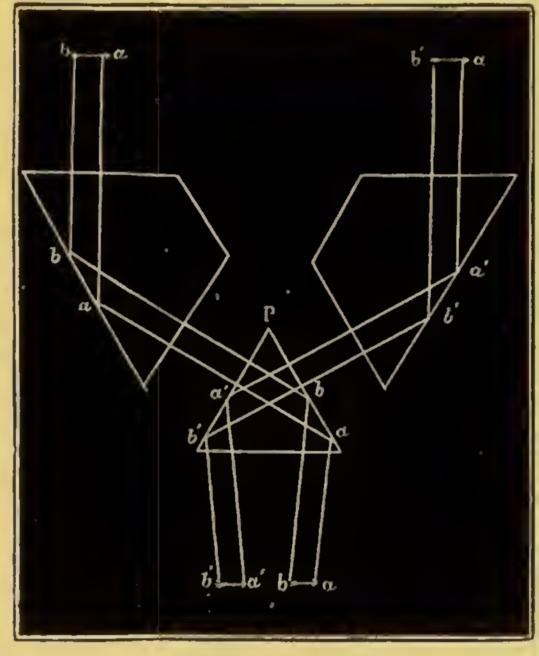

Fig. 16.

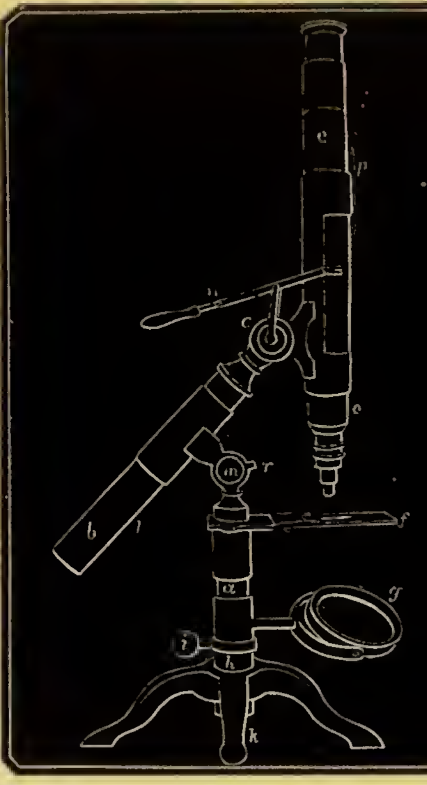

Fig. 17.

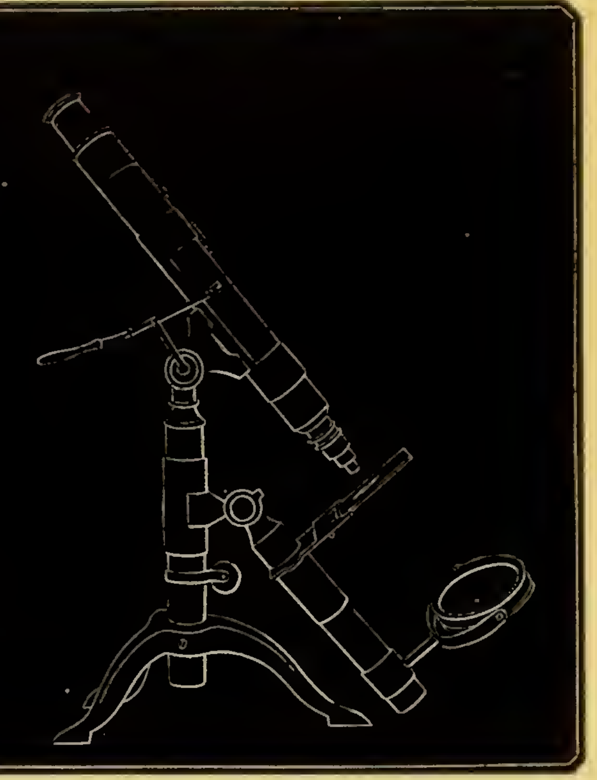

Fig. 15. Prisms in Nachet's binocular microscope. Figs. 16 and 17. Travelling microscope. *a.* Telescopic stem of the microscope made of brass tubes an inch in diameter. *b.* Horizontal arm of ditto. *c.* Body. *e.* Hinge joint. *f.* Stage. *g.* Mirror. *h.* Tube with clamp screw, *i,* in which the lower part of the stem slides. *k.* Lower part of stem, to which the mirror can be adapted. *l.* Ridge which prevents the horizontal bar from turning round. *m.* Hinge joint. *n.* Knee lever for adjustment. *o.* Fine adjustment screw. *p.* Pin which prevents the body being forced lower that the focus of the object glass.

[To face p. 12.]

PLATE VI.

Fig. 19.

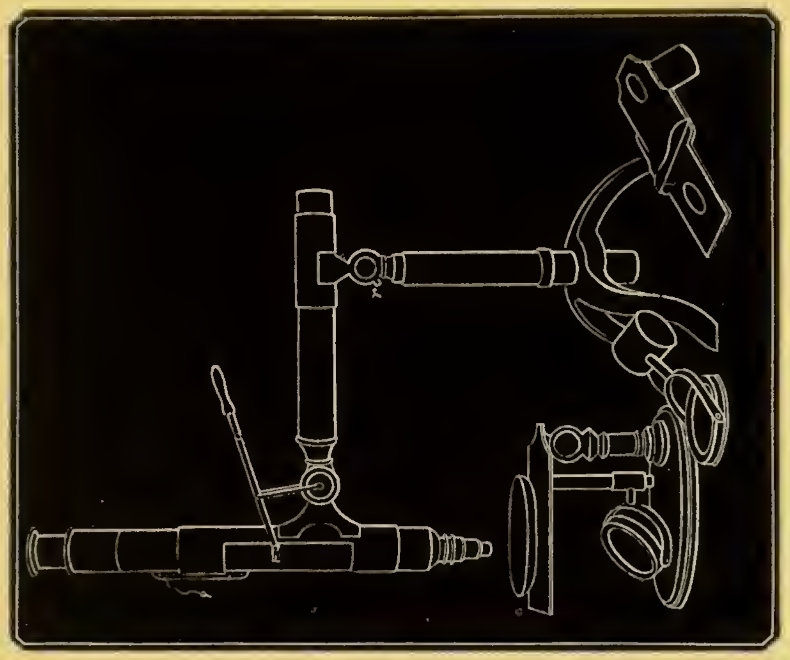

Fig. 19. Same instrument arranged for making dissections.

Fig. 18.

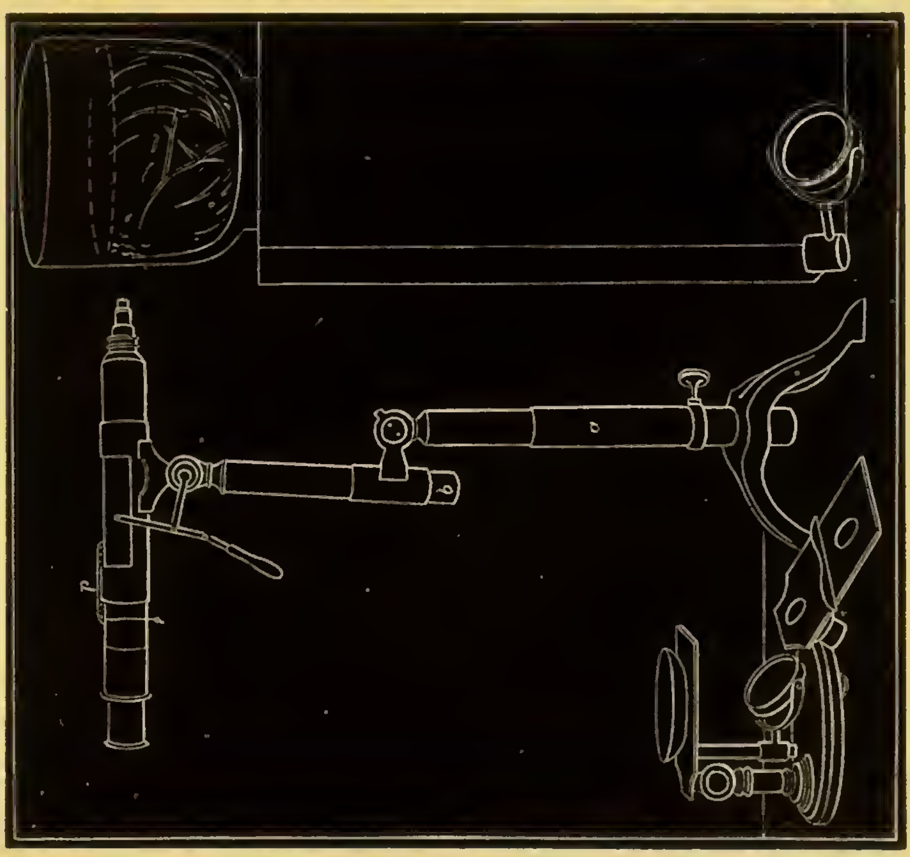

Fig. 18. The travelling microscope arranged for the examination of objects in a vivarium.

[To follow Plate V.]

PLATE VII.

Fig. 20.

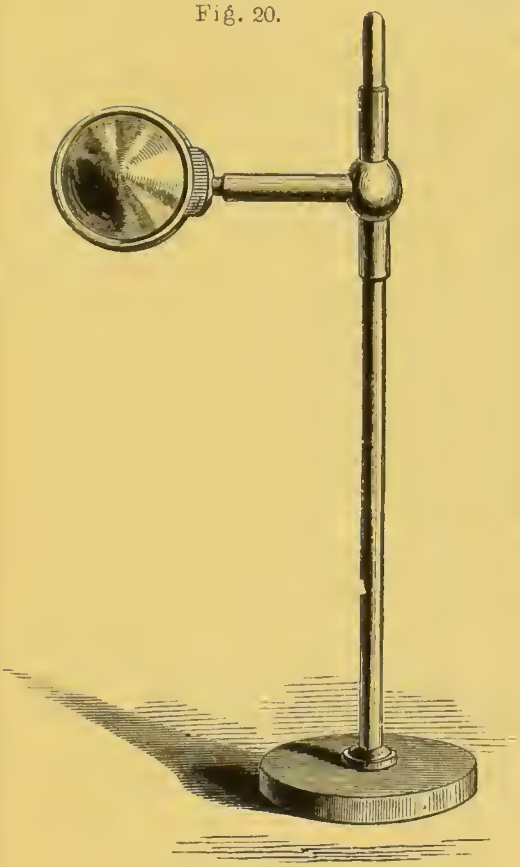

Fig. 21.

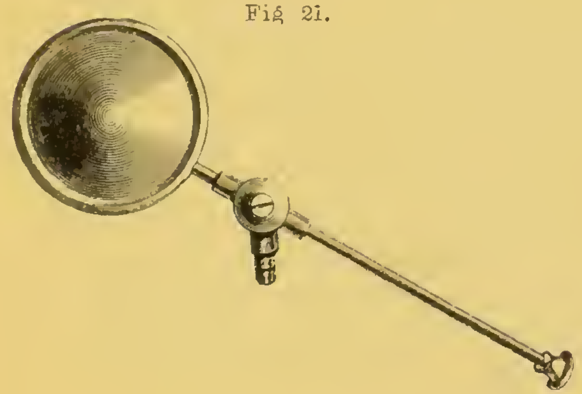

Fig. 22.

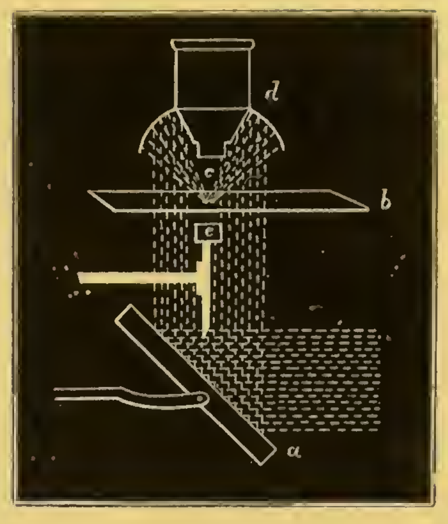

Fig. 23.

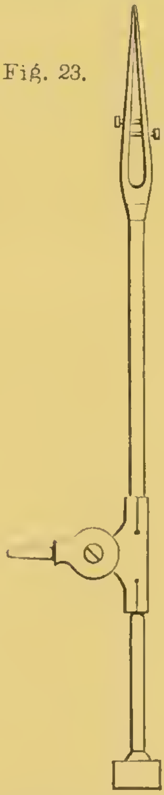

Fig. 20. Bull's-eye condenser for condensing a strong light upon objects. Fig. 21. Bull's-eye condenser to fit on to the stage (p. 14).

Fig. 22. To illustrate the mode of examining an object by reflected light with the Lieberkuhn. The light reflected from the mirror, *a*, passes through the glass slide, *b*, around the object, and impinges on the concave annular mirror, *d*, by which the rays are brought to a focus and condensed upon the object placed at *c* (p. 15).

Fig. 23. Forceps to fix upon the stage for holding small objects.

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PLATE VIII.

Fig. 24.

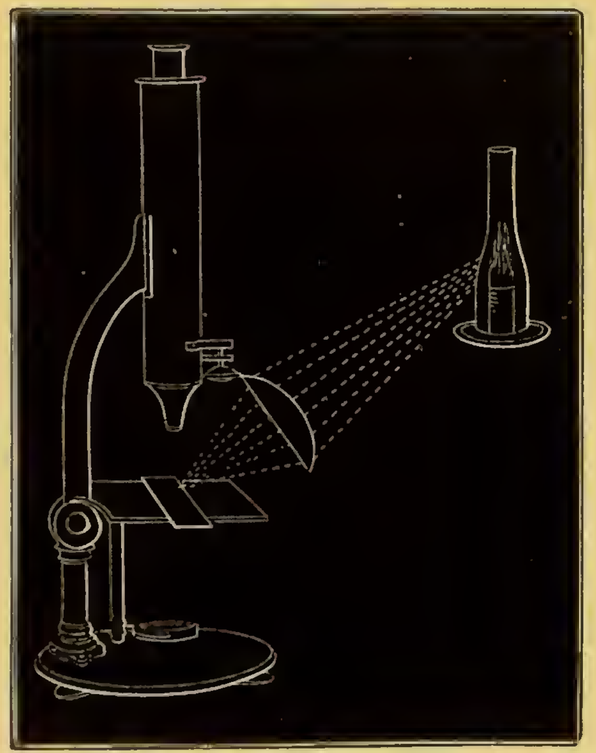

Fig. 24. Diagram to illustrate the arrangement for examination by reflected light (p. 14).

Fig. 25.

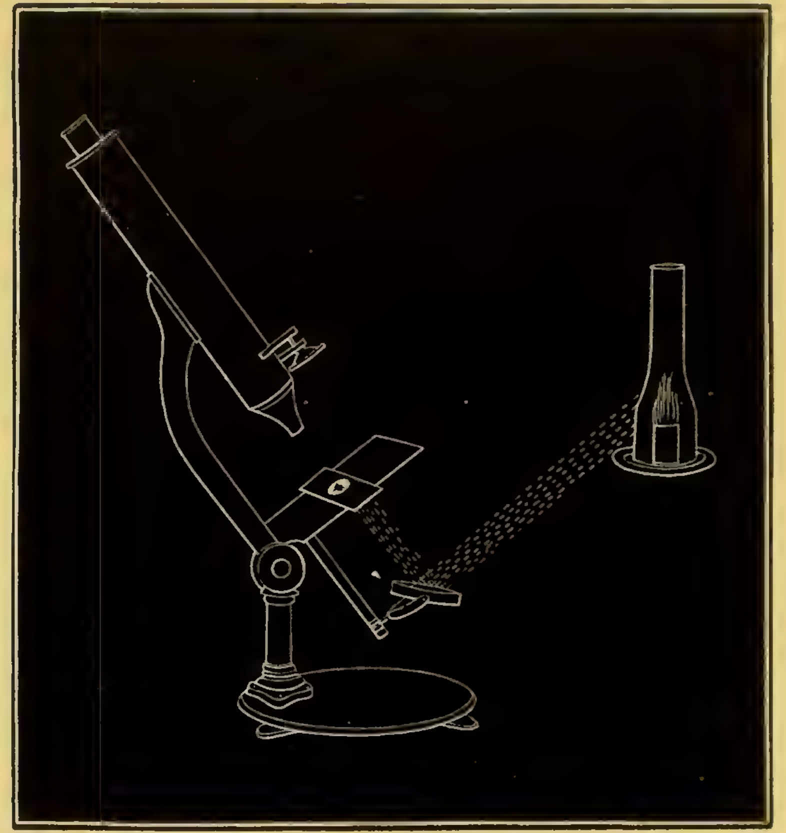

Fig. 25. Diagram to show the arrangement for examining objects by transmitted light (p. 17.)

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PLATE IX.

Fig. 26.

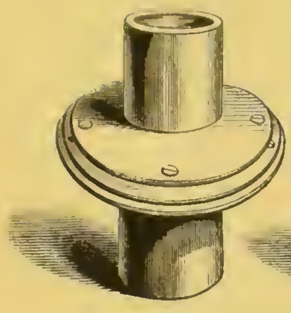

Fig. 27.

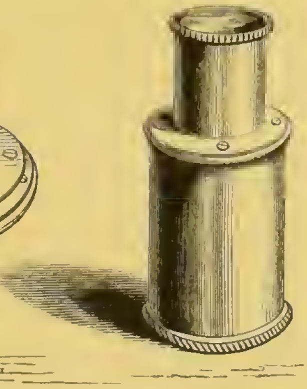

Fig. 28.

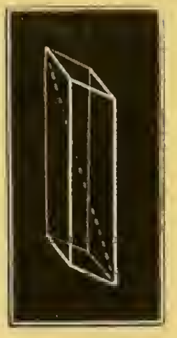

Fig. 29.

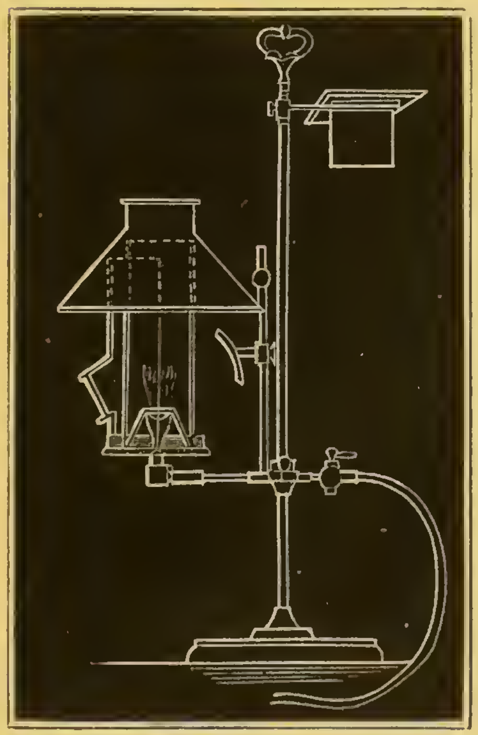

Fig. 30.

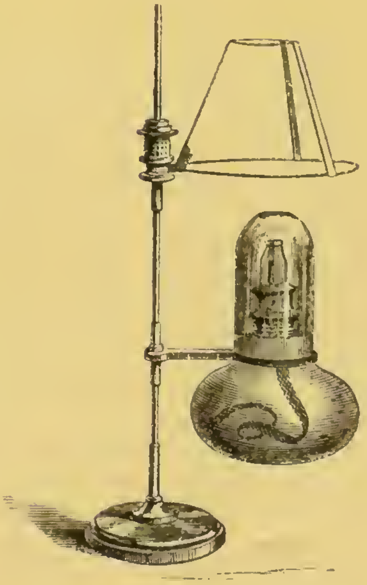

Fig. 26. "Polarizer" placed beneath the object. Fig. 27. "Analyzer" placed above the object Fig. 28. Nicol's prism divided and cemented together with Canada balsam, in order that one image produced by the double refracting spar may be refracted out of the field of vision (p. 18).
Fig. 29. Gas lamp arranged by Mr. Highley with water bath and hot plate (p. 19).
Fig. 30. Camphine lamp arranged by Messrs. Smith and Beck (p. 19).

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PLATE X.

Fig. 31.

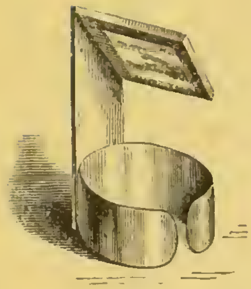

Fig. 32.

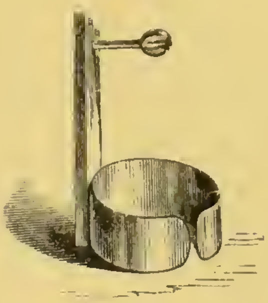

Fig. 33.

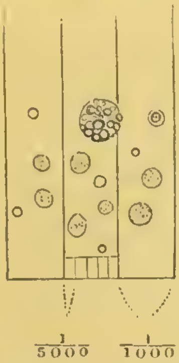

Fig. 34.

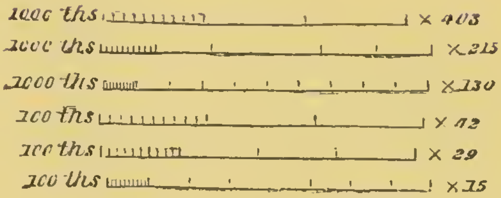

Fig. 35.

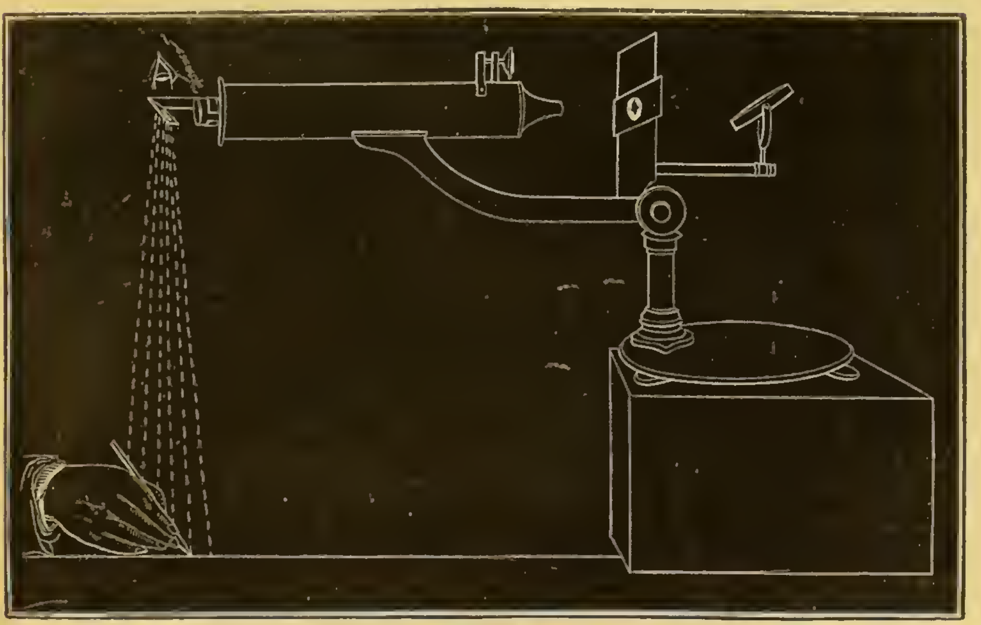

Fig. 31. Neutral tint-glass reflector arranged by Messrs. Powell and Lealand. Fig. 32. Steel disc (p. 20).
Fig. 33. Stage micrometer divided into 1000ths and 5000ths of an inch, magnified 215 diameters.
Fig. 34. 100ths and 1000ths of an English inch magnified in various degrees. The smallest divisions are 1000ths and 10000ths (p. 22).
Fig. 35. To illustrate the arrangement of the microscope for drawing and measuring objects (pp. 21—23).

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PLATE XI

Fig. 36.

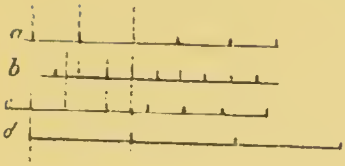


Fig. 37.

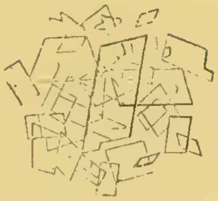


Fig. 38.

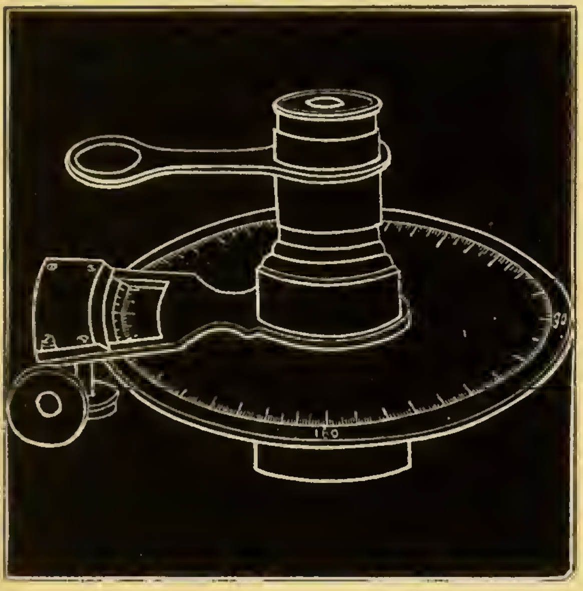
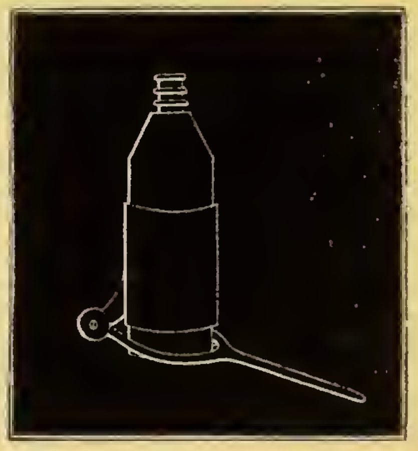


Fig. 39.



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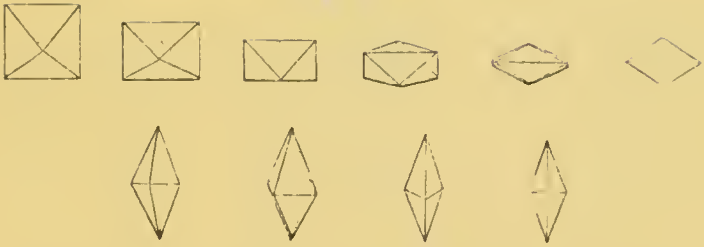

Fig. 36. Mode of ascertaining the magnifying power of an object-glass. *a.* 1000ths of an inch × 200. *b. Inch scale divided into tenths.* *c.* 1000ths of an inch × 130. *d.* 100ths of an inch × 40. Each magnified 1000th of an inch covers two-tenths, or one-fifth of an inch, therefore the glass magnifies 200 times, for $\frac{1}{1000} \times 200 = \frac{2}{10}$ or $\frac{1}{5}$ of an inch. Each 100th of an inch covers four-tenths of an inch, therefore the glass magnifies 40 times, for $\frac{1}{100}$th $\times 40 = \frac{4}{10}$ (p. 24).

Fig. 37. Crystals exhibiting acute and obtuse angles.

Fig. 38. Goniometer for measuring the angles of microscopic crystals (p. 23).

Fig. 39. Achromatic condenser with arrangement for altering focus, designed by Professor Quekett (p. 17).

Fig. 40. An octohedral crystal, one axis of which is shorter than the other two, to show the different appearance it exhibits when examined in different positions.

[To face page 24.]

PLATE XII.

Fig. 41.

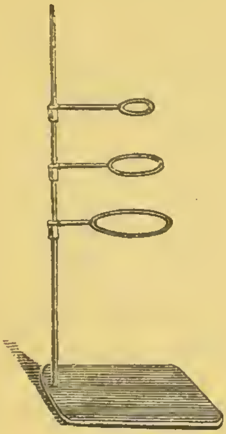

Fig. 42.

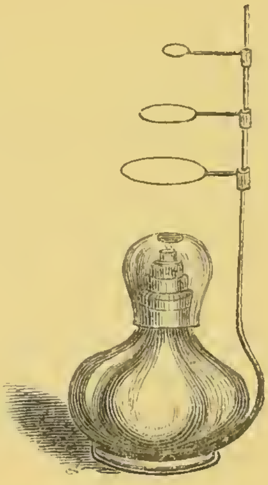

Fig. 43.

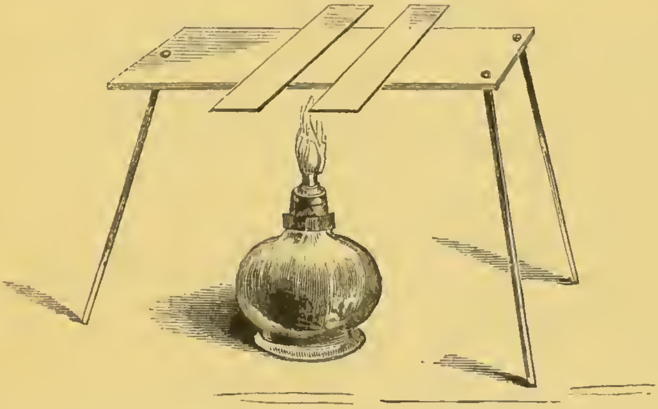

Fig. 44.

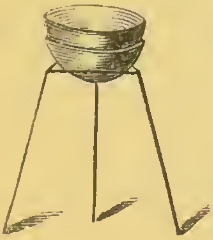

Fig. 45.

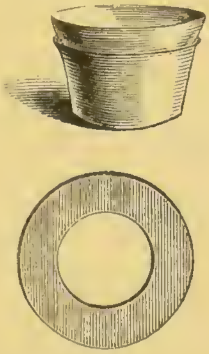

Fig. 46.

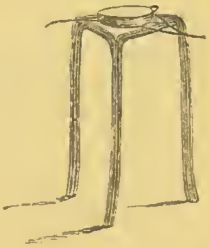

Fig. 41. Small retort-stand to support watch-glasses, &c. (p. 25).
Fig. 42. Spirit lamp with wire stand attached (p. 25).
Fig. 43. Brass plate for heating glass slides (p. 26).
Fig. 44. Porcelain basins arranged for a water bath (p. 26).
Fig. 45. Small copper bath, with ring to diminish aperture (p. 26).
Fig. 46. Tripod wire stand for supporting platinum basin containing matter for incineration (p. 25).

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PLATE XIII.

Fig. 47.

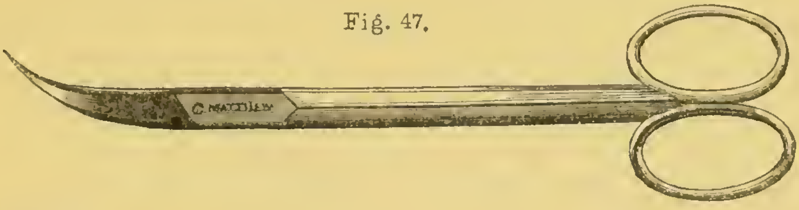


Fig. 48.

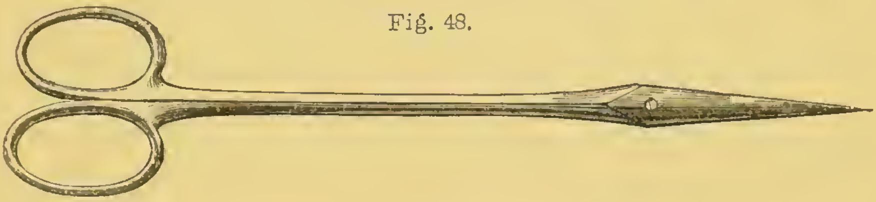


Fig. 49.

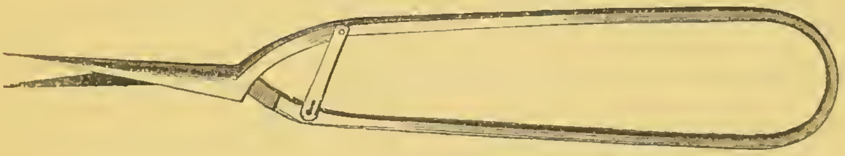


Fig. 50.

Fig. 51.

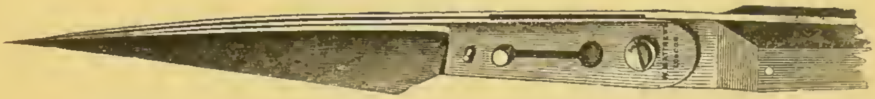


Fig. 52.

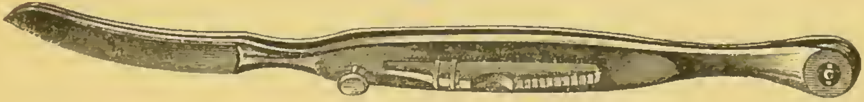


Fig. 53

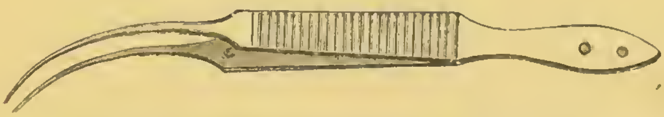


Fig. 47. Curved scissors, for cutting thin sections of tissues (p. 28).
Fig. 48. Fine straight scissors, for dissecting (p. 28). Fig. 49. Spring scissors, for making minute dissections (p. 28).
Fig. 50. Double-edged scalpel, for cutting thin sections (p. 26).
Fig. 51. Valentin's knife (p. 27). Fig. 52. Valentin's knife, as improved by Mr. Matthews (p. 27)
Fig. 53. Curved forceps, for dissecting.

[To face page 28.]

PLATE XIV.

Fig. 54.

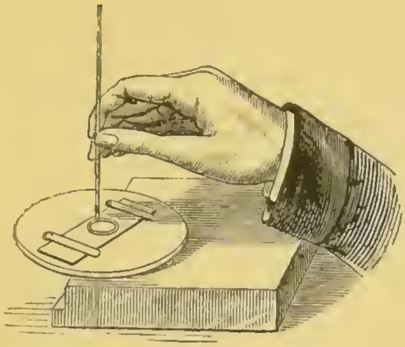


Fig. 55.

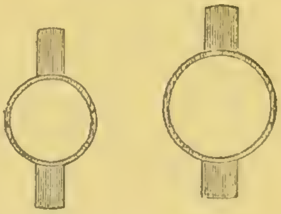


Fig. 56.

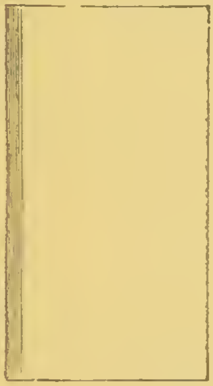


Fig. 57.

Fig. 58.

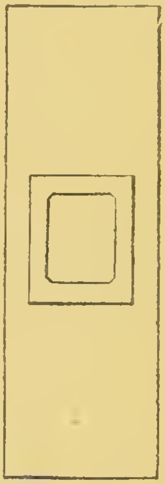
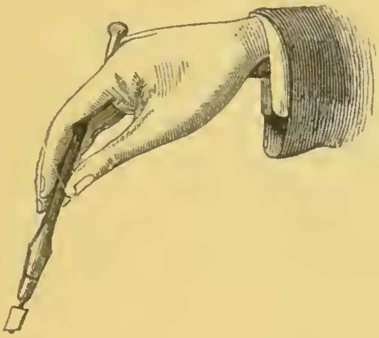


Fig 59.



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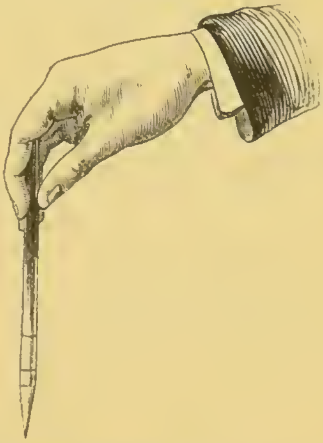

Fig. 54. Shadbolt's apparatus for making round cells of Brunswick black (p. 41).
Fig. 55. Flat brass rings for cutting circles of thin glass (p. 41).
Fig. 56. Plate glass stage for examining objects when immersed in acids or corrosive liquids.
Fig. 57. Large bradawl, for scraping away superfluous marine-glue in making cells (p. 42).
Fig. 58. Thin glass cell, for examining objects suspended in fluid (p. 43).
Fig. 59. To illustrate the manner in which the diamond is used for *cutting* thick glass (p. 41).
Fig. 60. Writing diamond for cutting thin glass (p. 41).

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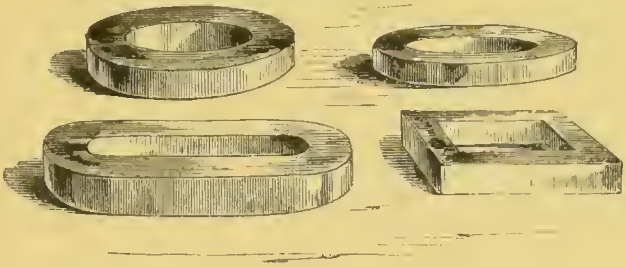
PLATE XV.

Fig. 61.



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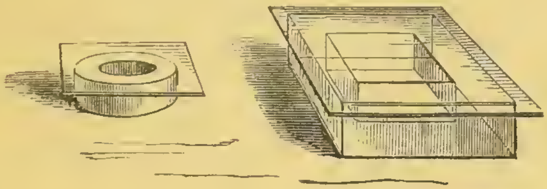

Fig. 63

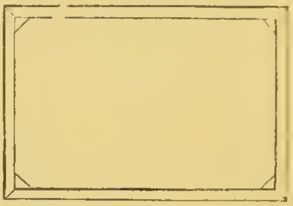

Fig. 64.

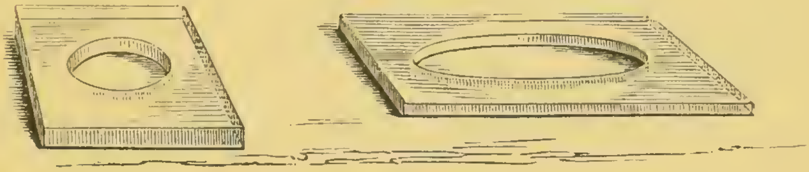

Fig. 65.

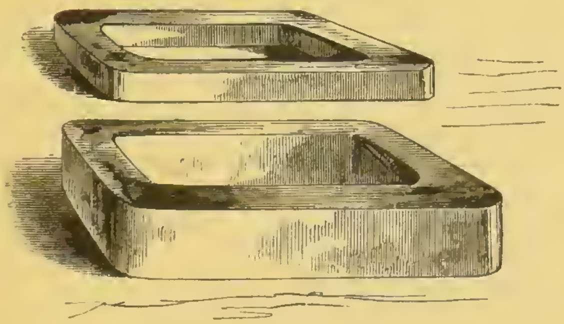

Fig. 66.

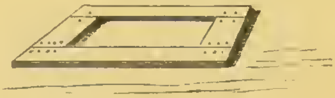

Fig. 61. Small cells for preserving injections and other thick preparations (p. 44).
Fig. 62. To illustrate the manner in which the thin glass may be perforated for making thin glass cells (p. 43.)
Fig 63. Shows the way in which the angles of a built glass cell are joined together (p. 45).
Fig. 64. Glass cells made by grinding out the centre of a piece of plate glass (p. 44).
Fig. 65. Large deep glass cells, for preserving opaque preparations (p. 44.)
Fig. 66. Illustrates a simple way of making a moderately thick glass cell (pp. 43, 44.)

[To face page 44.]

PLATE XVI.

Fig. 67.

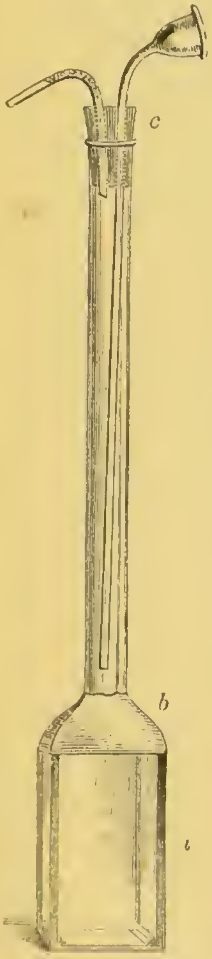

Fig. 68.

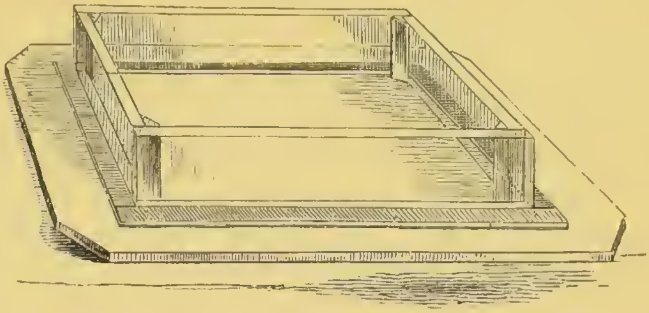

Fig. 69.

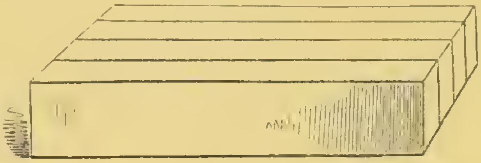

Fig. 70.

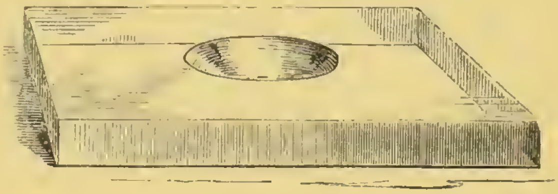

Fig. 71.

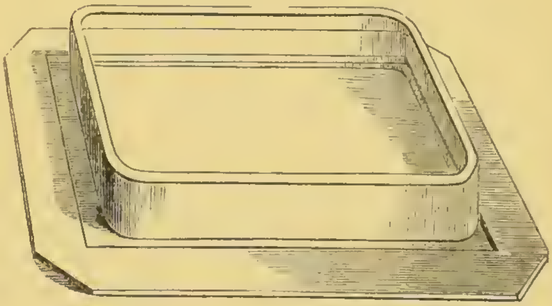

Fig. 67. To illustrate the manner in which cells of a peculiar shape may be made. The lower part is made of plate-glass, to which the tube is attached by gutta percha. This apparatus was made for examining the circulation in the branchiæ of a proteus. The smaller tubes were for the purpose of supplying the animal with fresh water.

Fig. 68. Large built glass cell (p. 44).

Fig. 69. Shows the manner in which the sides of built glass cells are cemented together in order to grind them perfectly flat (p. 44).

Fig. 70. Concave glass cell made by grinding out a cup-shaped cavity on the surface of a piece of very thick glass. It is afterwards polished (p. 44).

Fig. 71. Deep glass cell, made by bending a piece of glass in the blowpipe flame (p. 45).

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PLATE XVII.

Fig. 72.

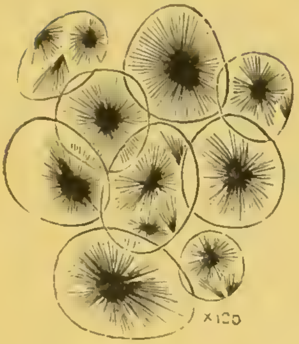

Fig. 73.

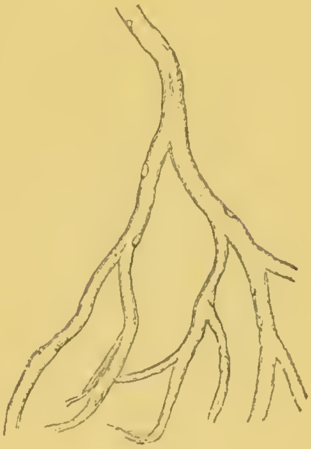

Fig. 74.

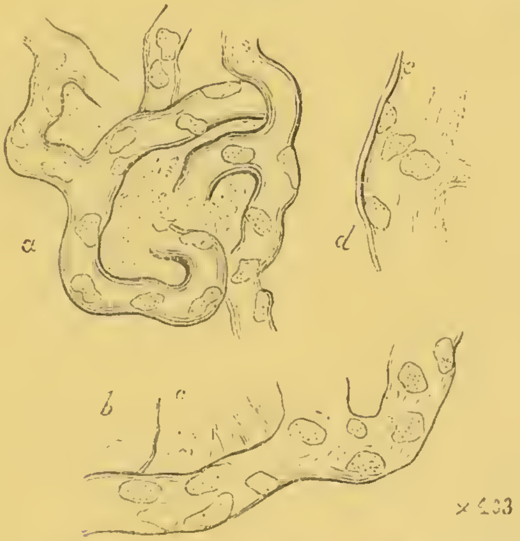

Fig. 75.

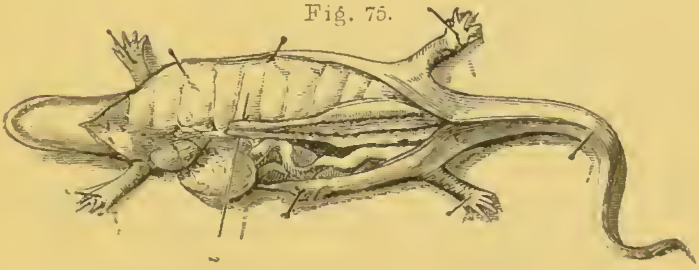

Fig. 72. Fatty tissue shewing fat vesicles, the crystalline fat has separated from the oily fat × 130.
Fig. 73. Small vessel dividing into capillaries × 215.
Fig. 74. Capillary vessels. *a.* Showing nuclei on walls. *b.* Fragment of a capillary vessel with membranes, *c*, attached. *d.* Another fragment flattened between the glasses (p. 49).
Fig. 75. Newt dissected to display the thin part of the kidneys, under which a needle, *a*, has been placed (p. 51).

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PLATE XVIII.

Fig. 76.

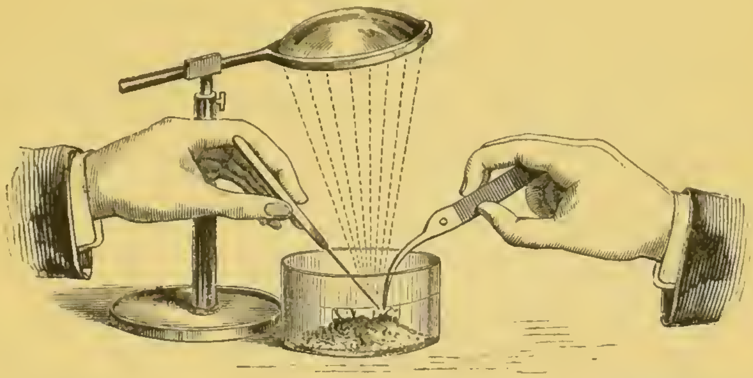


Fig. 77.

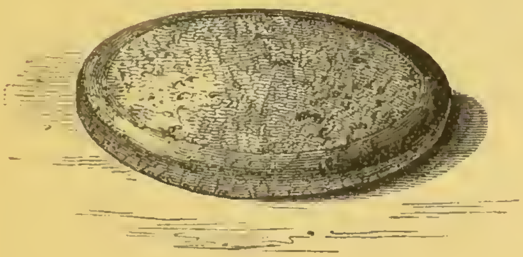


Fig. 78.

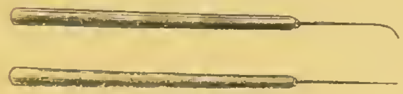


Fig. 79.

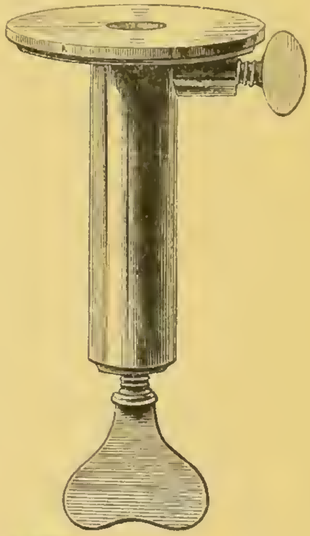


Fig. 80.

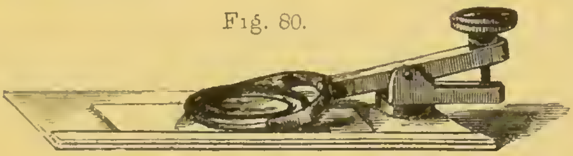


Fig. 81.

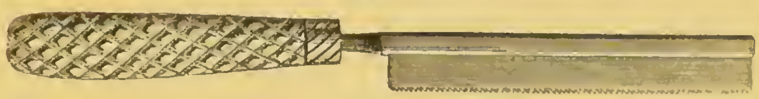


Fig. 76. Arrangement for dissecting objects under water. The bull's-eye condenser is larger than those represented in figs. 20, 21 (p. 52). It may be obtained of Mr. Matthews.
Fig. 77. Loaded cork, upon which objects for dissection may be pinned out (p. 53).
Fig. 78. Needles for dissecting (p. 28).
Fig. 79. Instrument for cutting thin sections of wood, &c. (p. 56).
Fig. 80. Compressorium, for pressing or tearing-up tissues under the microscope (p. 56).
Fig. 81. Saw for cutting thin sections of bone (p. 55).

[To face page 52.]

PLATE XIX.

Fig. 82.

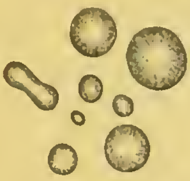


Fig. 83.

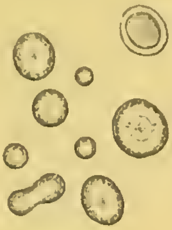


Fig. 84.

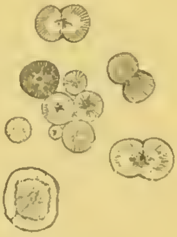


Fig. 85.

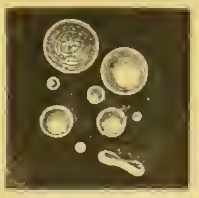
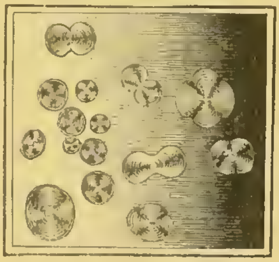


Fig. 86.



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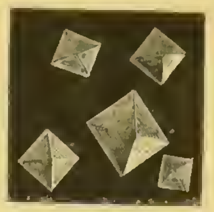

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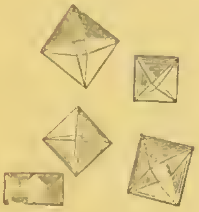

Fig. 89.

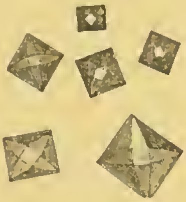

Fig. 90.

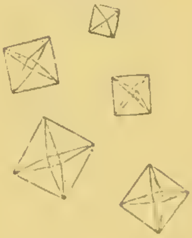

Fig. 91.

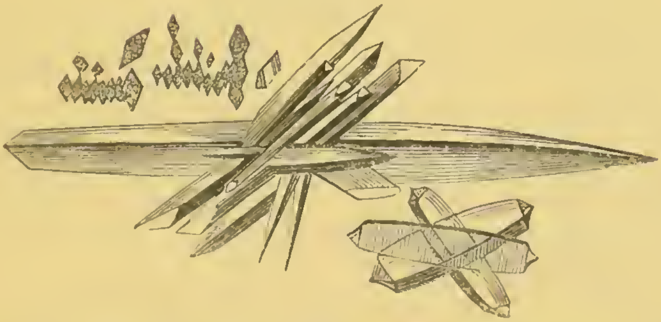

Fig. 82. Spherical crystallines of carbonate of lime, examined by transmitted light in air (p. 58).
Fig. 83. The same in water. Fig. 84. The same in Canada balsam. Fig. 85. The same under the influence of reflected light. Fig. 86. The same under the influence of polarized light (p. 58).
Fig. 87. Octohedral crystals as seen by reflected light. Fig. 88. The same in air by transmitted light. Fig. 89. In water. Fig. 90. In Canada balsam. The thin lines in the last case are caused by the refractive power of the crystal and that of the medium in which it is immersed being nearly equal.
Fig. 91. To illustrate the appearance of crystals when examined in their own mother-liquor.

[To face page 58.]

PLATE XX.

Fig. 92.

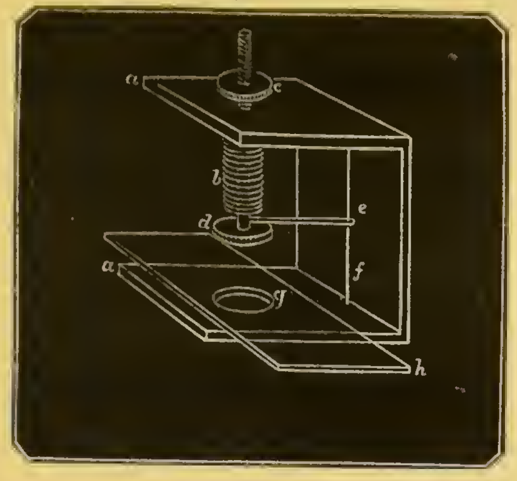

Fig. 93.

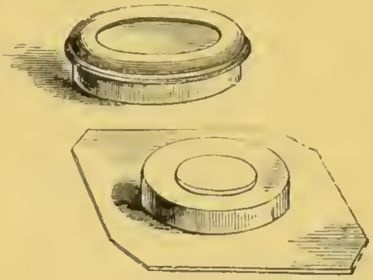

Fig. 94.

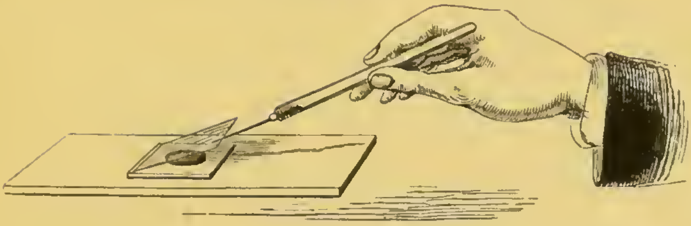

Fig. 95.

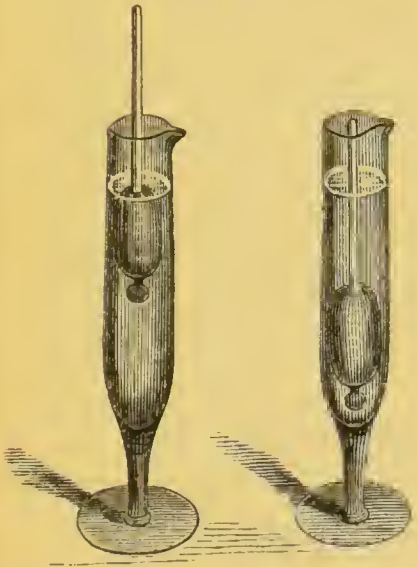

Fig. 96.

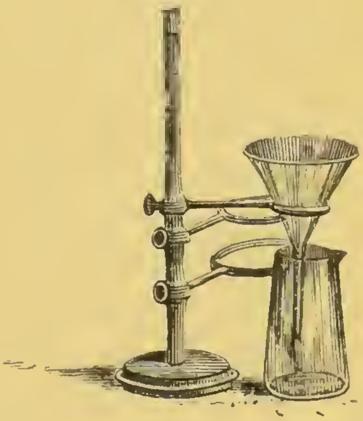

Fig. 92. Apparatus for pressing down the thin glass cover while cements are drying, arranged by the Rev. G. Isbell.
Fig. 93. Animalcule cage for examining strata of fluids of different degrees of thickness (pp. 46, 57).
Fig. 94. To illustrate the manner in which the thin glass cover is to be allowed to fall gradually upon an object to be mounted in fluid (p. 63).
Fig. 95. Glasses for taking the specific gravity of fluids and for allowing deposits to subside (p. 68).
Fig. 96. Shows how filtration may be conducted. [To face page 64.

PLATE XXI.

Fig 97.

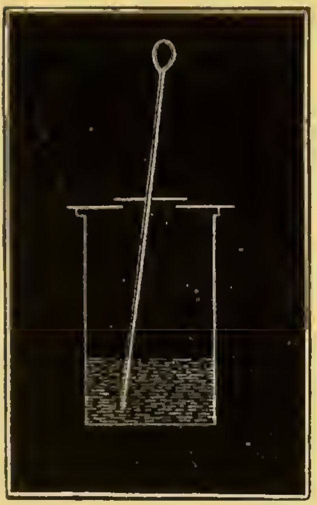

Fig 98

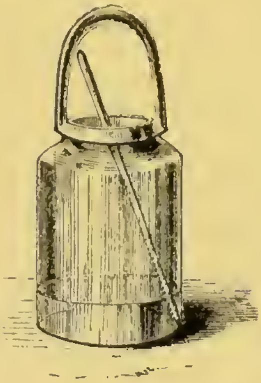

Fig. 99.

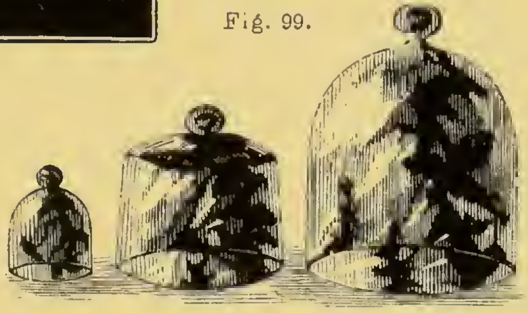

Fig. 100.

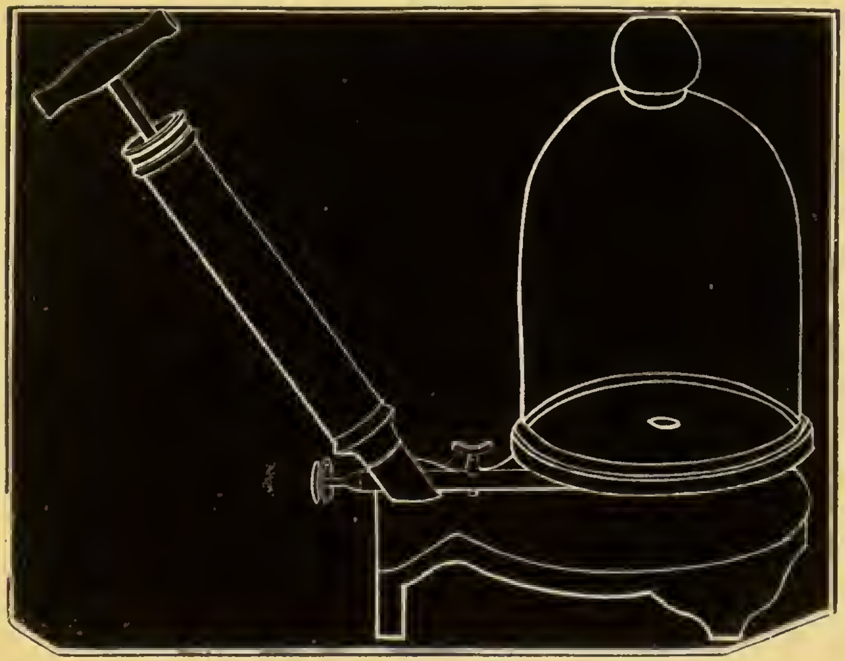

Fig. 97. Vessel for holding Canada balsam (p. 32).
Fig. 98. Vessel for holding gum, gold size, varnish, glycerine, &c. (p. 32).
Fig. 99. Glass shades for protecting specimens which are being mounted from dust (p. 63).
Fig. 100. Small air-pump for removing air from the interstices of a tissue (p. 66).

[To face page 66.]

PLATE XXII.

Fig. 101.

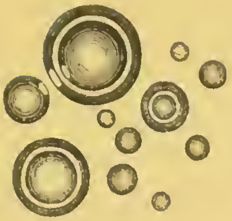

Fig. 102.

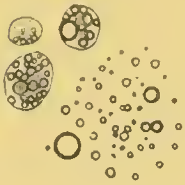

Fig. 103.

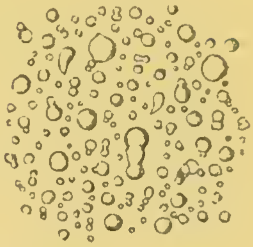

Fig. 104.

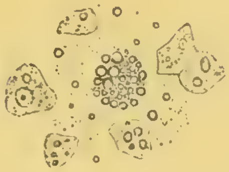

Fig. 105.

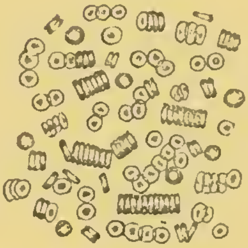

Fig. 106.

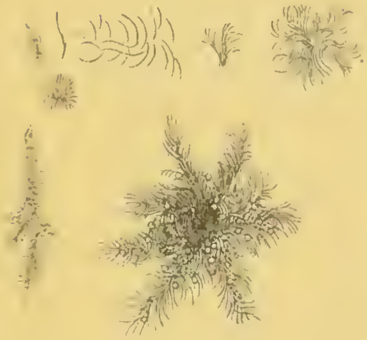

Fig. 107.

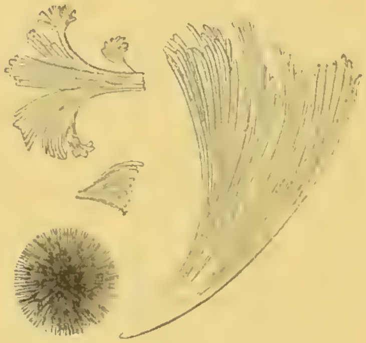

Fig. 108.

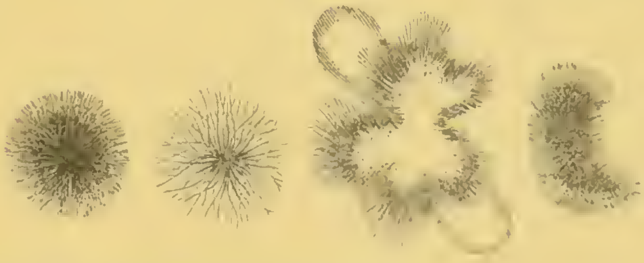

Fig. 101. Air bubbles of various sizes in water (p. 68).
Fig. 102. Oil globules, some free, others in envelopes (p. 68).
Fig. 103. Oil globules from milk. In some the investment of casein is dissolved and they are coalescing (p. 102).
Fig. 104. Liver cells containing oil globules. In the centre is seen a collection of oil-globules not surrounded by any envelope (p. 101).
Fig. 105. Blood corpuscles.
Fig. 106. Crystals of margaric acid.
Fig. 107. Crystals of stearic acid.
Fig. 108. Crystals of margarine separating from the oily fat or elaine.

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PLATE XXIII.

Fig. 109.

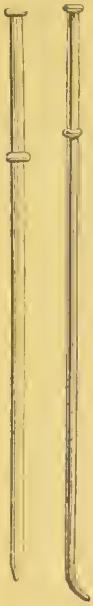

Fig. 110.

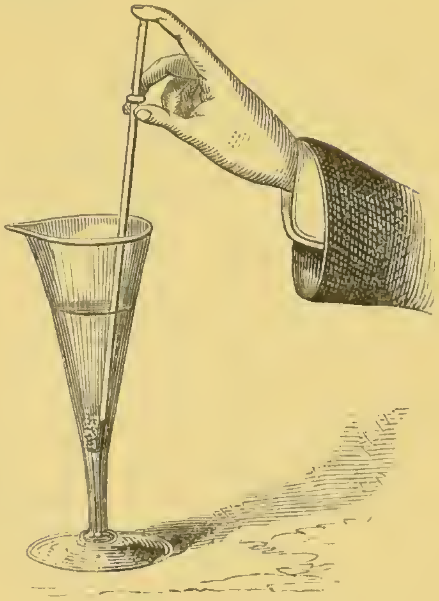

Fig. 111.

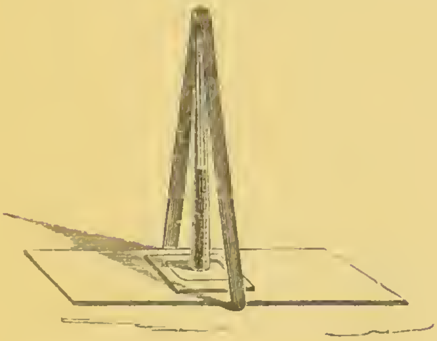

Fig. 112.

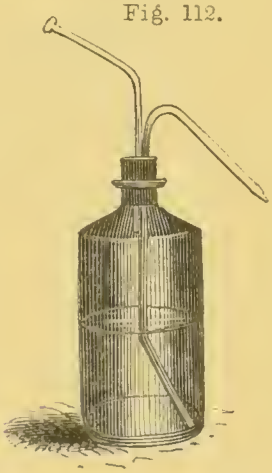

Fig. 113.

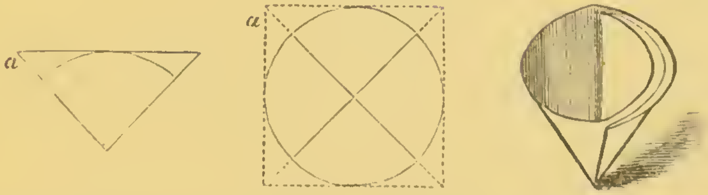

Fig. 109 Pipettes made of glass tube for separating deposits from fluids (p. 69).
Fig. 110. Illustrates the manner of using the pipette (p. 69).
Fig. 111 Shows the manner in which a very small quantity of deposit may be obtained from a fluid, by placing it in a test tube, and inverting it over the glass slide. It is kept in position by an India-rubber band shown in the drawing.
Fig 112. Wash bottle (p. 71).
Fig. 113. Illustrates the manner in which filtering paper is to be folded for filtering

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PLATE XXIV.

Fig. 114.

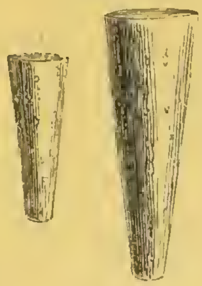

Fig. 115.

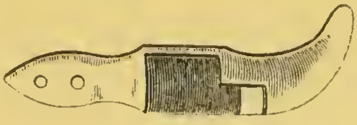

Fig. 116.

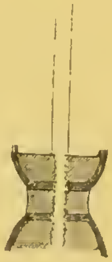

Fig. 117.

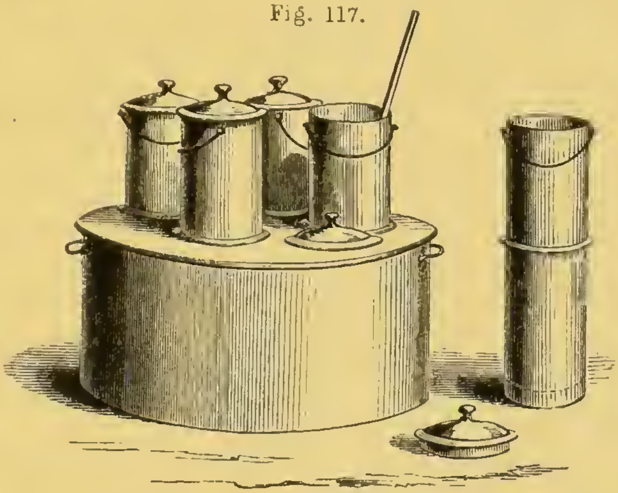

Fig. 118.

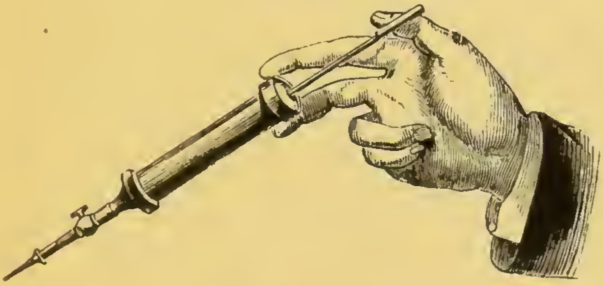

Fig. 119.

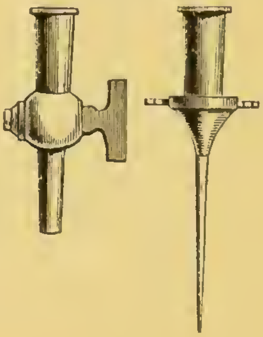

Fig. 120.

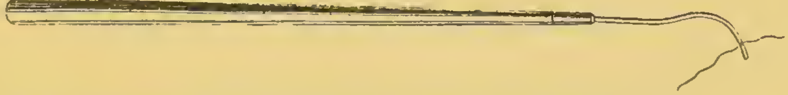

Fig. 114. Corks for stopping the pipe when the syringe is being refilled (p. 74).
Fig. 115. Bull's-nose forceps for closing an open vessel to prevent the escape of the injection (p. 74).
Fig. 116. Shows the manner in which the piston of the syringe is made.
Fig. 117. Injecting can for heating size. It may also be used as a water bath for drying objects, or for conducting evaporation (p. 74).
Fig. 118. Performing the operation of injecting (p. 80).
Fig. 119. Stopcock and injecting pipe, which fit on to the syringe (p. 74).
Fig. 120. Needle for passing thread round a vessel the cut end of which is to be tied on an injecting pipe (p. 74).

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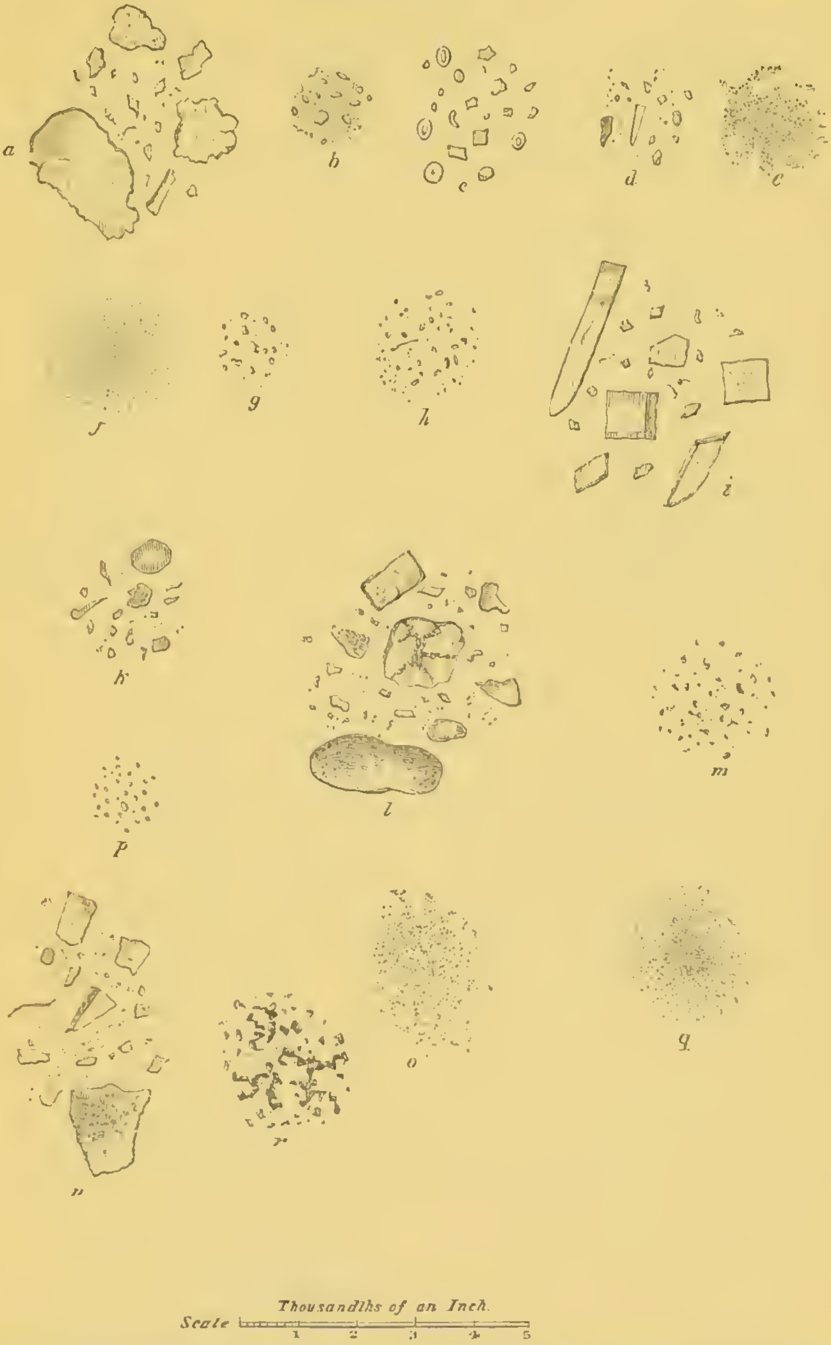
PLATE XXV.



Colouring matter used for injecting, showing the comparative size of the particles. *a.* Precipitated chalk purchased in a dry state. *b.* Chalk recently precipitated. *c.* Whitening. *d.* Prussian blue, as purchased. *e.* Recently precipitated Prussian blue. *f.* Freshly precipitated carbonate of lead. *g.* Dried carbonate of lead. *h.* Freshly precipitated biniodide of mercury. *i.* Dried biniodide of mercury. *k.* Indigo. *l.* Vermilion, as purchased. *m.* Levigated vermilion. *p.* Pure carmine. *n.* Dried chromate of lead. *r.* Freshly precipitated chromate of lead (hot solutions of bichromate of potash and acetate of lead). *o.* Freshly precipitated chromate of lead (cold solutions). *q.* Lamp black. × 215 (p. 75).

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PLATE XXVI.

Fig. 122.

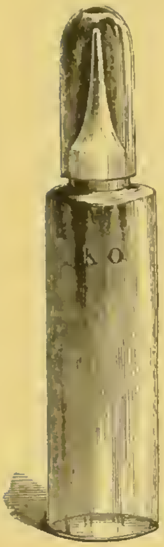

Fig. 123.

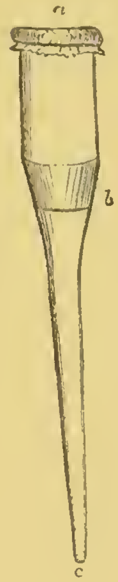

Fig. 124.

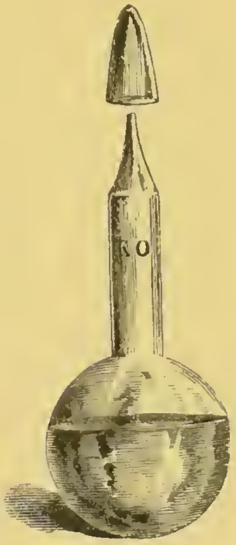

Fig. 125.

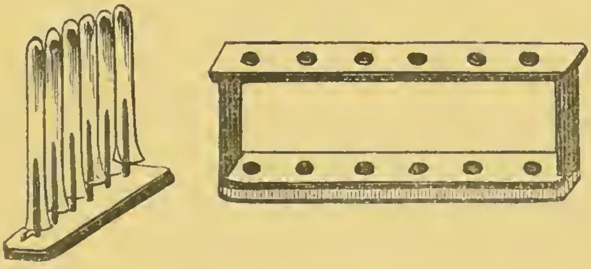

Fig. 126.

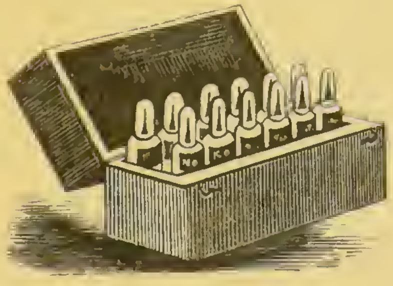

Fig. 127

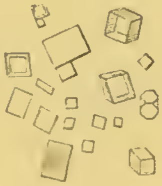

Fig. 122. Small tube with capillary orifice for microscopical testing (p 90).
Fig. 123. Tube with India-rubber, *a*, tied over upper extremity, to remove small quantities of test solutions from bottles. *b*. Ground, to fit into the neck of the bottle. *c*. Orifice.
Fig. 124. Bulb with capillary orifice (p. 90).
Fig. 125. Test tubes, rack, and drainer.
Fig. 126. Box with test solutions in bottles with capillary orifices.
Fig. 127. Crystals of common salt.

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PLATE XXVII.

Fig. 128.

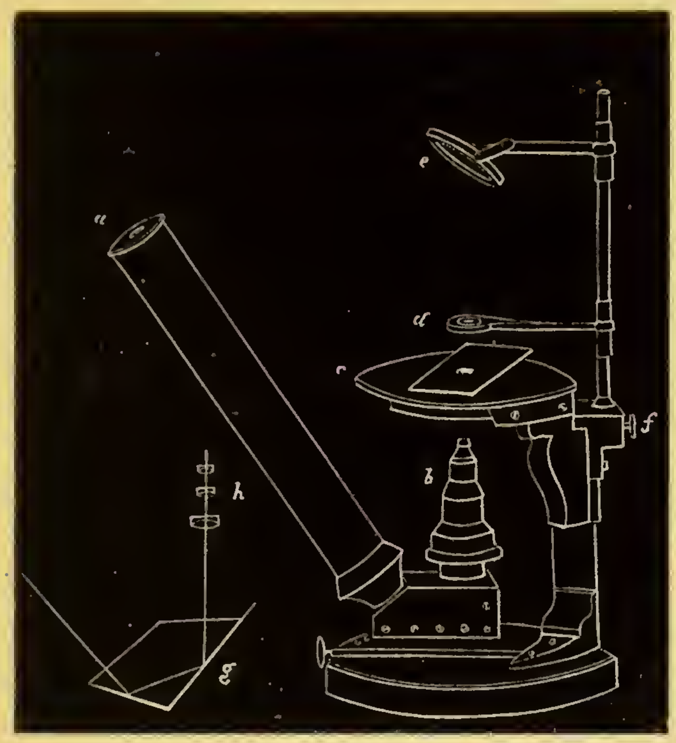

Fig. 129

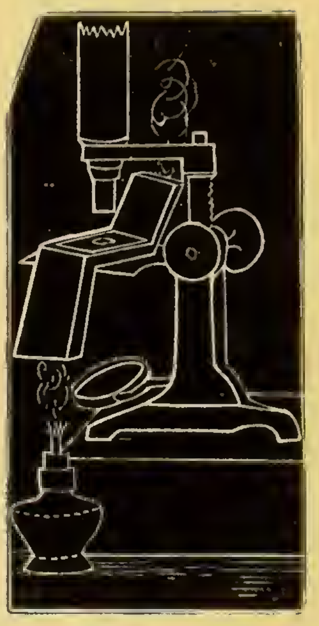

Fig. 130.

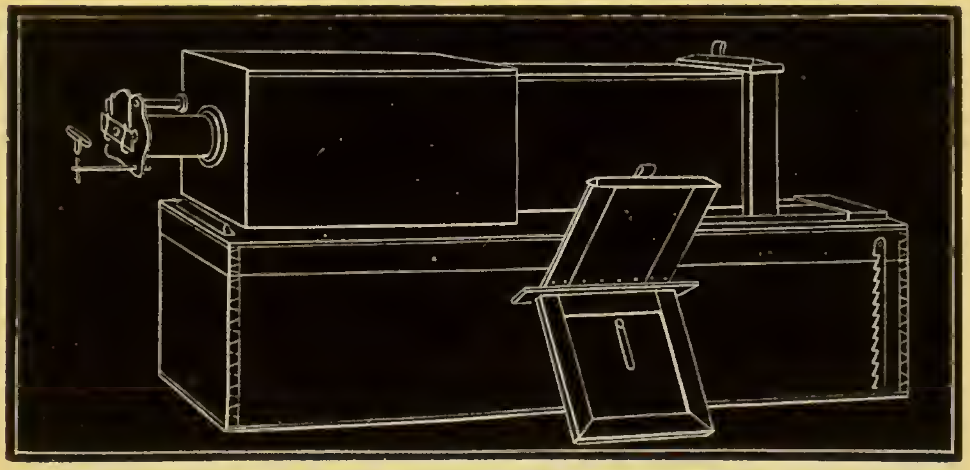

Fig. 128. Inverted microscope of Dr. Lawrence Smith, for examining objects in acid solutions, corrosive fluids, &c. *a*. Tube of microscope with eye-piece. *b*. Object glass over the box which contains the prism resembling that represented at *g*. *c*. Stage with slide upon it. *d*. Support on which polarizing apparatus or condenser may be placed. *e*. Mirror. *f*. Screw by which the stage is elevated or depressed in focussing. *g*. Prism showing the direction in which the rays of light passing through it are refracted. *h*. Position of achromatic object glass.

Fig. 129. Apparatus for examining objects while exposed to the action of a high temperature.

Fig. 130. Stage and mirror adapted to ordinary photographic camera for taking photographs of microscopic objects as arranged by Mr. Highley (p. 95).

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PLATE XXVIII.

Fig. 131.

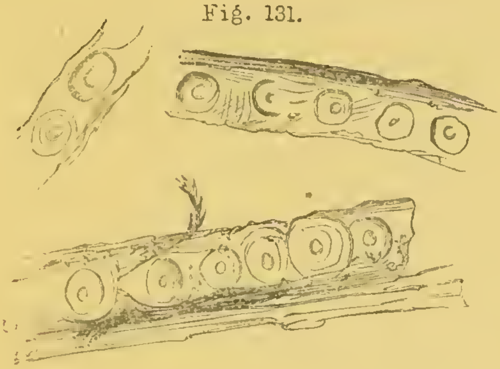

Fig. 132.

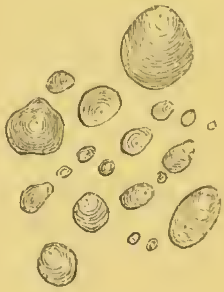

Fig. 133.

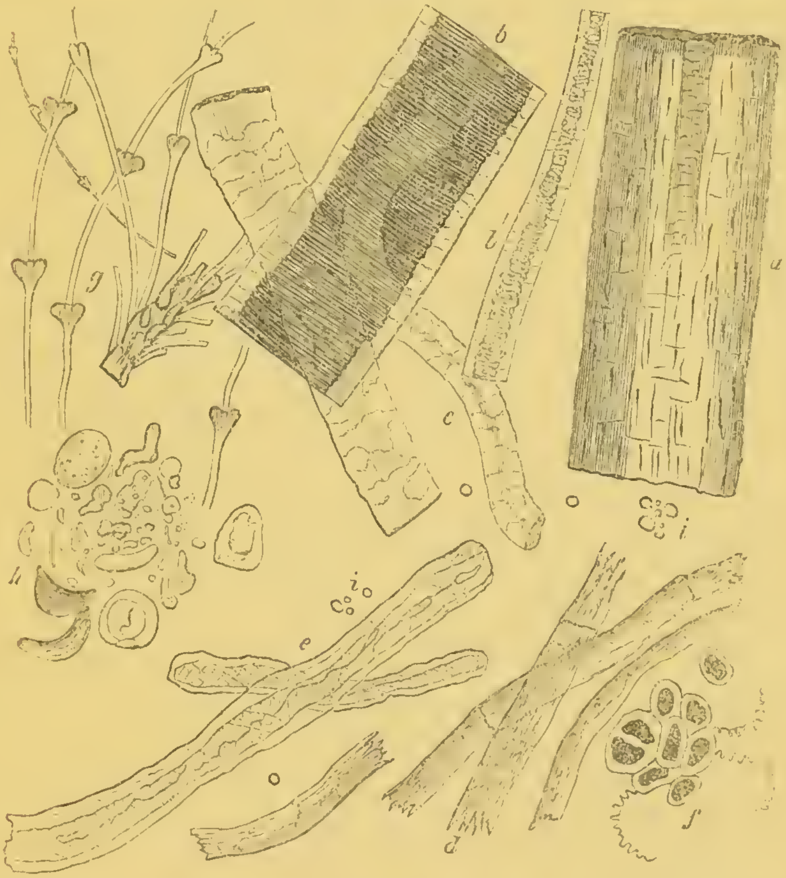

Fig. 131. Fibres of deal swept from the floor (p. 102).
Fig. 132. Globules of potato starch (p. 102).
Fig. 133. *a.* Fragments of human hair. *b.* Cat's hair. *c.* Hair from blanket. *d.* Fibres of flax *e.* Fibres of cotton. *f.* Fragments of tea-leaves, showing cells and spiral vessels. *g.* Portions of feathers. *h.* Bread crumbs, showing wheat starch partly altered by baking and maceration. *i.* Free oil globules (p. 102).

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